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ABSTRACT

This paper studies the needs and strengths of rural schools with the intent of improving rural science education. It examines the history of rural schools, and posits a rural-to-urban continuum of characteristics, citing studies that indicate rural schools are more effective in some ways than urban schools. The paper looks at needs of rural/small schools and the reasons those needs exist. Included is a list of recommendations by Kansas science teachers for addressing the needs of science educators generally. Also examined are the dynamics of change in rural schools and claims that many reform efforts have failed for lack of community consensus. Planning must be broad-based; technical assistance for implementation must be available to teachers; and change must be supported at the institutional level. Innovative approaches linking schools to their communities are suggested. Funding mechanisms are discussed. Conclusions are then synthesized from several other studies for improving science education in rural schools. Resources from outside the rural community will be needed, but sustained change will require support at the community level. This document includes reference list and tables. (TES)

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TOWARD IMPROVING RURAL SCHOOLS WITH IMPLICATIONS FOR THE TEACHING OF SCIENCE

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INTRODUCTION

In order to address the concerns of science education in the rural setting it is necessary to first discuss the general problems, strengths, and possibilities of rural schools. While specific science education concerns are the target of this paper, the fact that rural teachers must first be generalists rather than unidiscipline teachers requires that science education problems be addressed within the context of general education in these schools. Rarely do science teachers in rural schools have the luxury of preparing for a single subject area. Many teachers, in fact, must prepare for three or more subjects daily. Thus, much of this paper will be devoted to the general state-of-affairs of the rural school.

OVERVIEW

BACKGROUND

Around the turn of the century a movement toward school consolidation began. This movement resulted in the closing of most rural schools and subsequent busing of students to centrally located town schools. Few communities gave up their schools willingly. Rather, most consolidation efforts resulted from outside pressure (Nachtigal, 1982d; Rosenfeld and Sher, 1977). This consolidation effort was made under the rationale that larger and more centralized schools would be more efficient and effective. Consolidation efforts are still being made today. Nachtigal (1982d) points out that "...it is clear that the one-best-system approach exemplified by consolidation, standardization of educational practice, and centralization of decision making still pervade public policy today" (p. 16). Nachtigal further adds that even with widespread consolidation, many small schools (less than 300 K-12) survive because of geographic remoteness.

Given the above state of affairs, it is disturbing that very little evidence exists to support improved effectiveness and efficiency resulting from this consolidation effort. As Nachtigal (1982d) concludes, "Establishing cause and effect relationships between instructional outcome and school size or any other single variable is very tenuous" (p. 20).

In a recent study, Edington and Martellaro (1986) examined the relationship between school size and student achievement. Since earlier studies had produced mixed results - some small schools had higher achievement than large schools and some did not - they sought to make corrections for certain other predictors of student achievement. These predictors include the following: percentage of students in special education, average district teacher's salary, average years teaching experience in districts, percentage of teachers with advanced degrees, percentage of minority students, mobility rate of students in the district, and expenditures per pupil. Results of this study indicate that 1) there is no reason to believe that enrollment size is related to achievement, 2) the percentage of students eligible for Title I programs appears to be significantly related to achievement, and 3) ethnicity variables appear to be significantly related to achievement. Edington and Martellaro posit that most research in the past looked only at a single variable, school size, and did not account for other predictors of achievement. Results from their study suggest that academic achievement does not seem to be related to school size.

Another study conducted by Walberg and Fowler (1986) found similar results. They concluded that socio-economic status is positively related to achievement while per-student expenditures are insignificant predictors of achievement. However, after accounting for per-pupil expenditures and socio-economic status, school size was found to be negatively correlated with achievement; small school districts in general had higher achievement.

Clearly, past policy toward small schools has been promoted without sound evidence that "big" is really "better". In fact, the "one-best-way" approach to schools has resulted in the creation of urbanization of rural small schools (Rosenfeld and Sher, 1977). They state that reformers advocated the adoption of urban models even though they were rarely consistent with the conditions in rural communities or appropriate to the social and educational needs of rural children. External consultants were brought in to design the educational system in the mold of its urban/suburban counterpart. Why does achievement seem to not suffer? What are the strengths and needs of rural schools? The answer might be embedded in the unique characteristics of rural schools.

CHARACTERISTICS

"Obviously the characteristics distinguishing rural communities from urban communities are not clear-cut; rather, they form a continuum of rural to urban, with communities falling at

different points depending on their size, location, and cultural history" (Nachtigal, 1982b, p. 8).

Rural schools are no more appropriate for viewing as "one" type than are all schools, including urban and suburban schools. Rather, they are each separate entities depending on unique characteristics that are linked to community, geographic, and economic conditions. Perhaps the best way to view the rural school setting is through a rural community typology proposed by Nachtigal (1982a). Figure A depicts three categories and associated values, socio-economic, political, and school priority factors.

FIGURE A

CATEGORIES OF RURAL COMMUNITY FACTORS*

		Values	Socioeconomic factors	Political Structure/ locus of control	Priorities for schools
I.	Rural Poor	Traditional/ commonly held	Fairly homogeneous low income	Closed, concentrated, often live outside local community	Mixed and low
II.	Traditional Middle America	Traditional/ commonly held	Fairly homogeneous/ middle income	More open/ widely dispersed	High
III.	Communities in transition	Wide range represented	Wide range/ low to high income	Shifting from "old timers" to "newcomers"	Wide range, resulting in school being battleground

*Nachtigal(1982a, p. 274)

It is clear from Nachtigal's typology that rural schools, with their strong community ties, represent a diverse array of characteristics. Indeed, further breakdown into sub-categories

is possible. Perhaps the characteristic of rural schools that is most important is their uniqueness or "individuality".

Other characteristics of rural schools are relatively small size, remoteness from urban service centers, and a non-industrial economy. In terms of small size, it is not clear that all rural schools are small. Certainly some schools, through consolidation, are rather large, yet are located in remote areas. Conversely, some very small schools exist in close proximity to large cities. Remoteness from large service centers, or isolation, is also an important characteristic of rural schools. Nachtigal (1982a) states that, "...the answer to how isolated a school needs to be is 'it depends'" (p. 269). He further notes that, "The lack of a precise definition of rural is at least one reason that rural education has been largely ignored in recent years" (p.269). Without a clear-cut definition, public policy appears to be driven by the idea that the one-best-system approach is valid.

Finally, a study conducted by Horn (1987) provides rural/small school characteristics in terms of school quality and effectiveness.

> The purpose of this study was (1) to identify characteristics perceived by students, educators, school board members and the community to be the most important indicators of school quality and effectiveness, (2) to determine the degree to which these characteristics are present in selected small/rural schools, (3) to show the relationship, if any, between perceived quality/effectiveness and the wealth of the district, per pupil expenditure, enrollment of the district, pupil/teacher ratio and size of the district, and (4) to provide a profile of the districts perceived to have the highest and the lowest quality and effectiveness. (p. 44)

The school districts used in the above study were randomly selected from all public school districts in Kansas with a K-12 enrollment of less than 1000. This two-phase study had 27 districts in phase one and 28 in phase two. The first phase sought to identify characteristics in terms of school quality and effectiveness. Phase two determined the extent to which 31 selected indicators were perceived to be present in the repondents' schools. The five variables judged highest or more definitely present or true by the total respondent pool were as follows:

1. students take two or more years of science;

2. teachers have good attendance;

3. school maintains safe environment;

4. low crime rate exists; and

5. teachers are well prepared. (Horn, 1987)

Results from the second phase indicate the following:

<u>More Effective Schools Compared to Least Effective</u>

1. administrative salaries are higher;

2. districts in counties with lower density;

3. smaller percentage of students employed immediately after high school graduation;

4. larger percentage pursue some type of post-secondary education after high school graduation;

5. much more reliance on local sources of revenue;

6. higher adjusted valuation per pupil;

7. greater total wealth per pupil; and

8. generally, larger percent of students at all levels and in all areas exceed minimum score on Kansas Competency Tests.

<u>More Effective Schools Compared to State Average</u>

1. lower enrollment;

2. lower teacher salaries;

3. lower percentages of minority teachers and students;

4. lower population density in counties;

5. higher percentage of high school graduates attend two- or four-year colleges;

6. higher percentage of high schools graduates attend some type of post-secondary education;

7. lower dropout rate;

8. more reliance on local resources for revenue;

9. less federal resources;

10. higher school district revenue and general fund operating fund expenditures per pupil; and

11. generally, higher percentage of students at all levels and in all areas exceed minimum score on Kansas Compentency Tests.

STRENGTHS AND NEEDS

STRENGTHS

"Therefore any organization has to strive continuously for the orderliness of order and the disorderliness of creative freedom. And the specific danger inherent in large-scale organization is that its natural bias and tendency favor order, at the expense of creative freedom" (Schumacher, 1973, p. 229).

Schumacher has described a key strength of rural/small schools. Cyr (1959) advocates that small schools are not only necessary, they are desirable. He proposes that communities can take advantage of the inherent strengths of small schools and offer a model that even urban schools might emulate. His design is based on the following characteristics:

1. small schools serve small groups;

2. human relations are basic;

3. organization and operation are anticipated;

4. operation must be flexible;

5. personnel must be versatile;

6. facilities must serve multiple purposes;

7. pupils participate in policy and planning; and

8. the school is an integral part of the community. (Cyr, 1959)

Cyr's design has subsequently been found to represent many of the strengths of rural/small schools.

Pelton (1983) argues that rural/small schools, through their strengths, can do it better in terms of school improvement and staff development. This ability to improve is based on advantages such as the following:

1. rural teachers do not feel so isolated from the "seats of power" as they might in larger districts;

2. rural teachers often tend to be involved as leaders in community activities and thus feel added school responsibility;

3. small numbers of staff facilitate planning;

4. because of scarce resources, administrators and teachers have had to rely on creative and ingenious approaches in meeting challenges; and

5. integrating staff development goals, student needs, and community expectations is easier because teachers are usually intimately aware of district and community needs. (Pelton, 1983, p. 4)

In terms of assessing the problems of rural teachers it is often the case that strengths are not assessed. This activity gives the impression that there are only needs and problems in rural education and results in a deficiency "mindset."

Tyack (1974) asserted that it is only when we evaluate rural schools (teachers) based on an urban model of "one-best-way" that rural schools are ranked second best. Even then the results are suspect. Shroyer and Enochs (1987) studied the unique strengths of rural science teachers as well as their needs. They point out that more personal contact between teachers, administrators, students, and community is viewed as an asset. "This 'family atmosphere' or tight coupling of organizational parts can increase solidarity, collegiality and overall group functioning" (p. 41). In this study they point out that rural settings can be particularly advantageous for science education. As Colton points out, "The rural environment is an open book where plants and animals, rocks and soil, sun, wind and rain are available for study and where human use of these natural resources is also evident" (pp. 1-2).

Further, strengths of rural/small schools are overlooked as an object of educational planning, development, and training. Little regard is given the unique local characteristics of the rural environment. Hobbs (1987) states that "The locality is a fertile and accessible but underutilized educational environment"

(p. 29). He further adds that we need to understand that local economic development is tied to learning more about this local environment. While many teachers utilize their local environment to connect learning with reality, most curricular materials, with their strong urban bias, make the job difficult.

NEEDS

If we are to improve rural/small schools, we must understand their unique needs within the context of their inherent strengths. Much has been written about the needs of rural/small schools. Armstrong (1983) lists the following needs, synthesized from a 1982 national session on rural education:

1. adequately and appropriately trained teachers and administrators;
2. opportunities to develop curricular materials that use resources in the local setting;
3. a long-range planning capacity;
4. more cooperative schemes;
5. leadership development and linkages among leaders;
6. better ways to assess students' instructional needs;
7. sensitivity to rural needs at state and national levels; and
8. research on the effects of decreased federal funding in rural districts. (p. 1)

Some needs of rural/small schools relate to staffing, in particular, the recruitment and retention of qualified teachers. This is especially true in the area of science, since most science teachers are trained heavily in one discipline and lack the content to teach across other sciences. Gardner and Edington (1982) suggest that this recruitment/retention problem is related to the acceptance of geographic and or cultural isolation of teachers and their lack of time and expertise to prepare and organize appropriate curricula. In addition to geographic and cultural isolation, Davis (1987) adds professional and social as types of isolation. Professional isolation can be characterized by the inability of teachers to share experiences and learn from each other (Davis, 1987). As one teacher puts it, "I am the only teacher in town teaching my subject at the secondary level. Chances to discuss what is going on, what approaches are working

or not working well and to look at materials they may have and I don't are few and far between" (Davis, 1987, p. 13). In terms of social isolation, Davis points out that separation from family and friends and the difficulty in breaking into the social niches of small rural communities add to the overall isolation issue.

One area of needs that must be considered is that of curricular needs. Sher (1977) states that "Among the needs in this area (curriculum), highest priority must be given to the development of competently designed curricula that are appropriate to the communities in which they will be utilized" (p. 285). Sher points out that nearly everyone agrees that rural small schools need improved curricula. However, he further adds that they need their own, not the "metropolitan" versions of curricula. The science curriculum, as well as other areas, needs to take advantage of the rural setting, including the community and natural environments. Sher refers to the second priority as one "...to build a curriculum that reflects and enhances the natural advantages of rural communities" (p.285). Reasons for the scarcity of appropriate curricular offerings provided by Sher, are as follows:

1. there is no economic reason for publishers to produce books specifically for rural/small schools;

2. no agency, public or private, has funded the development of these curricula or curricular material; and

3. rural areas lack the necessary funds, time, and expertise to develop their own materials and curricula (p. 284).

Beckner, et al., (1983) identifies some specific teacher needs in rural schools. These include the identification of strategies for dealing with teacher burnout and provision of some type of incentive program to promote professional development. Beckner and other analysts suggest that these incentive programs, should include college credit, release time, or monetary compensation for professional activities. They contend that many rural teacher needs can be met through staff development programs. Staff development involves change. If we are to improve schools in rural areas, consideration must be made for the fact that many conditions that are necessary for change are lacking in these schools. According to McLaughlin (1982), "Typically, the educational problem addressed by a change effort is simply symptomatic of a subset of more pervasive difficulties" (p. 282). low income, for example, means less community concern and a lower tax base for the schools.

Finally, Enochs, Oliver, and Wright (1987) assessed the perceived needs and status of secondary science teachers in Kansas. Since

over 80% of Kansas is considered rural, the results likely reflect the needs of rural/small school teachers of science. All secondary science teachers (1400) were surveyed. Of these, 405 teachers returned a survey. The study indicated that there are similarities between rural and non-rural teachers. One of the highest concerns was in regard to the use of microcomputers. Also, teachers are highly interested in taking science content courses. It is also clear that teachers are not using the latest innovations and instructional techniques. Science teachers did express a strong interest for inservice in science content, instructional materials, and new teaching strategies, with high preference for summer course offerings.

The following recommendations to address the needs of science teachers were generated from the findings:

Recommendations

1. A state-wide effort to systematically provide inservice science courses which are available, particularly during the summer, for teachers in all areas of the state;

2. Teachers need to be informed about effective teaching strategies and subsequently be instructed as to their specific use in the science classroom and laboratory;

3. Adequate support should be in place in order to assure that effective teaching strategies are adopted and implemented by science teachers;

4. A state-wide effort should be made to encourage more females and minorities to pursue science teaching careers;

5. School districts need to vigorously seek out and employ qualified female science teachers;

6. Serious consideration should be made for the adequate funding for the frequent use of field experiences, particularly in the earth and biological sciences;

7. Science education inservice should focus on innovative instructional materials and new teaching strategies;

8. The adoption of innovative strategies should employ the use of long-term programs with teachers involved in the planning and delivery of these programs;

9. Universities need to place a high priority on delivering on- and off-campus science content courses during the summer;

10. Microcomputers, including interactive video, in the science classroom should be promoted through teacher inservice programs and adequate funding of software and hardware; and

11. Undergraduate preservice science education programs need to insure that their graduates have the latest knowledge and skills reflected in the above recommendations.

RURAL SCHOOL IMPROVEMENT

After discussing the strengths and needs of rural schools, the next step is to address needs within the context of school improvement or staff development. This includes school change, community development, and research. McLaughlin (1982) claims that many rural school improvement efforts have failed because there was little local consensus about the problem as defined at the national level and thus a commitment to these projects was not forthcoming. He further adds that, "...if they do not perceive anything seriously deficient in their present practices they are not likely to endorse a school reform program" (p. 282). This indicates that if we are to improve rural schools through change efforts, an understanding of the change process in the rural setting is essential. "A careful examination of the case studies suggests that the success of rural school improvement programs depends on how well they fit local community needs as well as local educational needs" (McLaughlin, 1982, p. 283). In addition, a thorough understanding and monitoring of improvement processes through research is needed.

RURAL SCHOOL CHANGE

McLaughlin (1982) suggests three key factors in rural school improvement (change) efforts. These are as follows:

1. broad-based planning;

2. providing implementation assistance; and

3. building an institutional base.

Establishing a broad-based planning effort, according to McLaughlin, means involving all of the important actors in

defining and planning school immprovement. Central to this defining and planning is making sure that the effort is not totally external. All parties involved, including local community leaders, students, teachers and staff need to be involved in the process. McLaughlin points out that, "In a rural community where the school's business is also the community's business, planners and advocates of change must enlarge their notion of the relevant actors in the planning process" (p. 284).

Providing implementation assistance is also essential if the change effort is to succeed. Too often "hit-and-split" efforts such as workshops are expected to provide lasting results. According to McLauglin, sound assistance, including technical advice, consultation, and moral support should be provided during the course of the improvement effort. This assistance should be available when needed and responsive to local concerns and changes. Because rural schools have fewer specialists and technical experts than their urban counterparts, they are likely to have greater and more frequent need for technical assistance than urban schools undergoing similar efforts (McLaughlin, 1982). In areas such as mathematics and science, the one-of-a-kind staff has no one else to talk to who is involved in the change. Team work is often not possible. Although technical assistance can help alleviate the problem of the "lone" teacher, outside help must be handled carefully. According to McLaughlin, outside experts are often considered insensitive to local problems and are sometimes viewed as wanting to do something to the school rather than for it. Leadership development within the rural school through technical assistance can provide a cadre of local leaders capable of implementing change from within. Caution should be made, however, in placing leadership roles on teachers without training in the area leadership. Teachers are trained to teach, not lead.

McLaughlin emphasizes that building an institutional base means that when the project ends and/or the money runs out, the change effort will continue. This requires a sufficient level of expertise and local support within the school and community. Included in this base should be the provision for continual training of new leaders and experts since staff turnover is usually high in rural schools. Another important aspect of building this base is to insure that project activities become regular or institutionalized routines. This may include budget line and personnel assignments (McLaughlin, 1982). Many projects that have historicaly required high levels of funding have failed because rural schools could not pick up the cost when the money ran out. Perhaps smaller ventures with local resources are the best targets for successful change efforts.

COMMUNITY DEVELOPMENT

As stated earlier, if school improvement efforts are to be sustained after start-up funding, some cost is always involved. Thus, to improve rural school community support is vital. Storms (1981) states that, "One rarely finds a fine school system in a declining community, and one never finds a declining school system in an attractive community" (p. 14). He further adds, "In this sense then, the development of the community leads to the improvement of the rural school, and improvements in rural schools leads to improved rural communities" (p. 14).

The development of community resources is directly related to the success of rural/small schools (Hobbs, 1987). Schools should participate in community planning and development. Teachers and administrators are often leaders in the communities in which they live.

Further, programs that enhance the development of small businesses and industry, schools provide a most important and necessary resource, human capital (Hobbs, 1987). Hobbs states that, "The quantity and quality of human capital available is an especially significant constraint to rural community development - migration drained it and rural industrialization did little to create a local demand for it" (p. 30). He suggests meeting this human capital need by keeping the graduates at home. He points out that, "Some adjustments are required - new and different skills and new methods of providing them are essential to serving new approaches to economic development and responding to some of the niches in rural localities" (p. 30).

With consolidation essentially over and many rural/small school communities in economic disarray, Hobbs contends that new approaches must be found to provide improved education. Sharing teachers and telecommunications are not new, but more attention to these and other innovative approaches needs to be considered. Certainly, adult education and retraining are important for the development of communities. Adults, according to Hobbs, are often "left behind", when rural communities can no longer afford the luxury of adult education programs. New models and programs should be developed in rural areas that address the improvement of school from a "K-through-lifetime" perspective.

COMMUNITY

The development of new programs and models to improve rural/small schools requires funding. However, the rural/small school typically is not set up to respond to federal or state funding

requests (Hearn, 1981). Most small schools do not have personnel to respond to such requests, nor are they set up to deal with the necessary accounting procedures. The ability to write fundable proposals is often lacking in rural/small schools (Hearn). Certainly, technical assistance in the area of grant writing is needed. This would include improved communication networks to alert rural/small schools to funding as well as techniques in proposals writing. Finally, according to Hearn, "...present federal formula, criteria, and procedures do not mesh with the conditions for rural and small school education" (p. 10). In fact, many agencies do not list ruralness or isolation as a criteria for underserved populations in their reuqest for proposals.

At issue in working toward rural/small school improvement, according to Nachtigal (1982c), is the acceptance by outsiders, including funding sources, of the "rural reality." This includes the following:

1. accepting that rural schools and communities are different from urban counterparts;

2. accepting the fact that rural communities differ from each other and that interventions to improve rural/small school education must recognize these differences; and

3. accepting the fact that rural/small schools and communities operate as a single, integrated social structure. (p. 30)

Perhaps Commoner's (1971) first law of ecology, "Everything is connected to everything else" (p. 33), is analogous to the rural/small community setting. In fact, the ecological description implied is an accurate one in that these rural school communities are indeed ecosystems of sort. The term ecosystem is usually applied to a particular setting that is relatively self-sufficient. Commoner refers to these systems as having multiple, interconnected parts. If we impact one part, then others are often affected. Examples of this are the training of rural youth to perform in the workplace, fostering migration, and subsequent economic decline in some rural communities. Rural/small schools are interconnected systems consisting of school staff, citizens, leaders, businesses, churchs, and civic groups. Although urban and suburban settings have the same parts, they do not have the degree of interconnectedness that rural areas have. This is particularly true considering the many roles that people play in rural communities. It is not rare to find a teacher who occupies every role listed above. The strengths and weaknesses of the rural school community ecosystem are in its ability to respond, as is true in ecology, to outside pressures and influences.

THE SCIENCE PROGRAM IN RURAL/SMALL SCHOOLS

As was pointed out in the introduction, it is difficult to address science teaching in rural/small schools without looking at the general context of rural/small school education. Several authors have addressed the specific problems and possibilities of science teaching in this setting. Jinks (1981) points out that there are two major problems facing the rural science teachers. First, he states that the increasing decline of scientific literacy is a problem of national concern. He proposes that many rural students come to view the universe as a conglomerate of unrelated operations; in many cases they may have no view at all beyond immediate time and space. The rural setting provides excellent opportunities for teaching science as a process of knowing about the relationships among scientific concepts. However, most rural science teachers are expected to be the entire science department and thus lack sufficient depth to teach such relationships. Second, Jinks points out that the recent exponential growth of science knowledge causes rural teachers to be overextended in terms of content, given present and past training of science teachers choosing the rural setting. These teachers - and trainers of rural science teachers - face the dilemma of needing to be generalists with in-depth knowledge in all fields of science. Irion and Jinks (1982) claim, however, that the rural science teacher's ability to work closely with students utilizing strong interpersonal skills has allowed them to do a superior job in science teaching compared to their urban counterparts. Irion and Jinks note also that although National Assessment of Educational Progress Test (NAEP) scores show a decline in science achievement, rural students do not contribute to the decline. Certainly, this should be comforting to rural educators. However, much can be done to improve science teaching in rural/small schools. Perhaps the comparison with norms in urban areas is not an adequate measure of success.

Simpson and Marek (1985) advocate a move toward concrete instruction, laboratory-based, in science. Historically, rural schools, have not provided adequate laboratory-based instruction due to higher costs in equipment and physical facilities. Simpson and Marek propose that more schools should consolidate classes by moving cooperative teachers back and forth between districts. Although this is ceraintly not new, distance learning techniques provide new mechanisms and add to the possibility of such cooperative efforts. Finally, Simpson and Marek contend that students in large schools do better in terms of cognition development in science. This is contrary to NAEP results and could be attributed to test content.

Another suggestion that is common in the rural science education literature is that of connecting science instruction to the rural

environment. Finson (1985) contends that earth science is not only relevant to rural youth, but that it is easily tied to their everyday lives. Many students work on the land and indeed their family's livelihood is dependent upon their knowledge of weather, soils, and climate. He states that, "If the rural student is provided these areas of knowledge through earth science, his/her problem solving capabilities can only be increased and thus increase and enhance his/her chances of survival well into the future" (p. 18). Dreyfus (1987) suggests that this connection is not possible but necessary between science and agriculture. He contends that although it is well understood that science is important in agriculture, the potential role of agriculture in science teaching has been neglected. He points out that, "...modern agricultural education cannot anymore limit itself to the acquisition of technical skills, of a 'savoir-faire,' or of recipes which are transmitted from father to son and from teacher to pupil" (p. 23). Dreyfus cites two reasons for making use of the agricultural context in science education. First, he says that, "According to the modern vision of science education, the sciences are an integral part of the general education of all the 'clients' of any educational system" (p. 26). Because of this, he states that it would be unwise to limit the scope of teaching agriculture to the study of only techniques. Further, he adds, "When conceived as an enriching component of science education, the teaching of agriculture corresponds better to the needs of the future agriculturist, from socio-human as well as from the agro-technical point of view" (p. 26). Secondly, Dreyfus states that the "web" of intellectual and practical activities called agriculture embraces many of the components of modern science teaching, including biology, physics, and chemistry.

An experienced rural science teacher suggests that there are six vital relationships to establish and maintain concerning successful science teaching (Craig, 1981). Most important among these relationships, according to Craig, is the one between teachers and students. He contends that the special characteristics of rural schools make possible a level of involvement that is seldom found in larger schools. Not only are there smaller classes, but teachers have the same students for five or six years. The second relationship is with students outside of class. This refers to the student-teacher interaction that takes place outside the classroom. This situation is much more likely to occur in rural communities than in larger cities in that teachers fill many roles in the school and community outside of the formal classroom. These roles offer, according to Craig, an opportunity for students to see teachers in a different light, particularly as the community science expert. A third relationship is one between the science teacher and parents. Indeed this relationship is rare in urban areas, but common in rural/small schools. Craig views parents as invaluable resources that can provide opportunities to help cultivate student interest in science and gain a broader perspective of student needs and

background. Fourth, is the relationship between the science teachers and the community. Craig states, "By maintaining an open and active involvement with the community, we find a valuable source of ideas and experiences which increase the relevance of our courses (science) and enrich our lives as well as those of our students" (p. 2). Fifth, among Craig's relationships is that of "beyond the community." He states that, "Few rural science teachers can afford to overlook any reasonable source of supplies or assistance" (p. 2). Industries, businesses, and state and county agencies are examples of sources that need to be cultivated by the science teacher. Finally, a relationship between the teachers and the science education profession is essential. Craig suggests that, "The more 'dried-out' we allow ourselves to become through lack of contact with others who are excited about teaching and through lack of contact with new ideas, the more susceptible we are to ineffectiveness and to burn-out" (p. 2). Another aspect of a professional relationship is that of belonging to professional organizations such as the state science teachers association. Shroyer and Enochs (1987) point out that effective leaders for instructional improvement in science teaching showed a strong commitment to organizations and saw value in reading science teaching publications.

Probably the most definitive work on rural science teaching is that of R. W. Colton (1981). Colton asserts that, "If science is learning facts from a book and carrying out more or less complicated 'experiments' to demonstrate something that is already well-known to the teachers, and perhaps to the students, if science is always a distillation of reality and never the real thing itself, and if scientific disciplines are specialized, distinct areas of knowledge unallied and unalloyed with the other subject areas, then the rural school is at a serious disadvantage" (p. 1). If, on the other hand, Colton adds, "...we look upon science as an exploration of our surroundings, as a method of finding out about things, and as something that, through the medium of technology, has a profound effect on all our lives, then the rural school is at an advantage" (p. 1).

Colton, as did Dreyfus, suggests that rural science education should blend in with the social sciences and technology, not taught as isolated disciplines. He contends that science should be part of an overall picture. He further adds that small numbers of students may not justify the teaching of highly specialized science courses in the traditional fashion because of the demand for specialized equipment. He adds, "However, such small classes offfer the incomparable advantage of allowing young people to be treated as individuals, not as items in a mass production system" (p. 4). The lack of specialists in physics, chemistry, and biology is a disadvantage to these schools if such courses are required and specialists in each are not available, which is usually the case. This forces, often times, science

teachers to teach courses out of their area of science. Colton supports the notion that we need to look hard at the idea of interdisciplinary science courses based on themes such as the energy crisis. He contends that this approach is particularly effective if designed locally with local resources and situations in mind. As others have already noted, if special courses are to be designed it will require outside resources and expertise. He adds, "Perhaps if rural science teachers could find this support from their specialist collegues living within a reasonable distance, and if, together, they could design science programs particularly suited to their schools and communities, they would find their jobs a little more congenial and professionally satisfying and they might be less anxious to move on to 'something better'" (p. 5).

In summary, Colton (1981) offers the following strategies for improving rural science education:

1. The initiative and financial support for a change in rural science will likely have to come from the outside the individual school system;

2. The organization proposing the change would need to approach districts and form a network of interested teachers;

3. Most expert help would need to come from colleges and universities along with support from specialists in the area and community;

4. Once participating staff are identified, some sort of teacher-directed conference, course, or workshop should be planned;

5. Training should be done locally with high teacher involvement in planning;

6. Continued district support for teachers is essential; and

7. The school board, community members, parents, and businesses should be involved from the earliest stages of the project.

FINAL THOUGHT

All evidence supports the contention that if we are to improve rural science education, resources from outside the community

will be needed. Certainly, some communities will be able to share more of the costs than others, but some assistance will be needed. The governmental/private sector funding agencies appear to be the answer. However, it is almost certain that any sustained change will need support from the local community. Alliance efforts may be the answer, in part, to the problem.

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